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The Relations of Comparative Anatomy to Comparative Psychology. LUDWIG EDINGER. Translated from the German by H. W. RAND. *The Journal of Comparative Neurology and Psychology,* November, 1908.

The aim of this article is to point out how comparative anatomy studied in connection with the observation of the organism may be of service to comparative psychology.

The author divides the brain into the palæencephalon and the neencephalon. The former, which is the oldest part of the brain, is present in all forms of life from the cyclostomes to man. Its general type remains unchanged throughout the evolutionary scale although the different parts may vary greatly in size. That a knowledge of the palæencephalon is of value to the sense psychologist is shown by a study of that part of it which has to do with the sense of smell. The anatomy of this portion of the brain reveals a constant arrangement and microscopic structure in all vertebrates from man to the cyclostomes. Because of this fact we may infer that all animals which possess this structure smell, even when we can not infer anything very definite from their behavior.

In the next place, a knowledge of anatomy reveals new problems for the sense psychologist. For example, in birds we find a large fiber tract which leads from the nucleus of the trigeminus, and terminates in a field known as the lobus parolfactorius. In fact, in all vertebrates up to mammals there evidently exists a sense which is localized about the mouth and has its center in the lobus parolfactorius. This lobe which is well developed in birds and certain lizards, and also in those animals in which the snout plays an important part, has almost entirely disappeared in man. Here we have an oral sense which is of the greatest importance to certain forms of life, yet it is a sense about which we, as yet, know almost nothing.

The study of the bony fishes is especially important because in them the palæencephalon alone is present. By a careful study of their behavior we can determine the activities which are characteristic of the palæencephalon. And "since it is certain that the palæencephalon persists quite unchanged even after a well-developed neencephalon has been added to it, there is no ground for regarding those activities which we recognize as palæencephalic in one class of animals as anything else, or as otherwise localized in higher animals. Furthermore, we may regard an entire series of activities as common to all vertebrates, and we may then seek to ascertain how other activities are added to those when a new structure is added to the palæencephalon. All sense impressions and movement combinations belong to the palæencephalon. It is able to establish simple relations between the two, but it is not able to form associations, to construct memory images out of several components. It is the bearer of all reflexes and instincts." If the palæencephalon can not form associations, then it is clear why animals which possess only the palæencephalon do not respond to certain sense stimuli, for these stimuli can not mean anything to them. It is the biological stimuli alone which arouse them to action. It is evident that here is an inviting field for the psychologist.

The neencephalon, the bearer of the cortex, is present as a rudiment even in the selachians, and becomes more and more conspicuous in the amphibians, and especially in the reptiles. It is in the neencephalon of reptiles that there appears for the first time a mechanism which provides for the possibility of association. We can now "declare with certainty that the oldest cortex becomes connected with those parts of the palæencephalon which serve the sense of smell and the oral sense, and subsequently other cortex regions are gradually superadded to this."

With the appearance of the neencephalon occur marked changes in the behavior of the organism. These changes as they appear in the reptiles may be summarized as follows: They are no longer dependent on the sense impressions of the moment but are influenced by earlier impressions; they learn more easily than fishes and amphibians; they associate certain sense impressions which are connected with the olfactory and oral senses; to a certain extent they foresee, and they exhibit individual differences. These facts are without doubt due to the appearance of the neencephalon. It is here that the true psychological states make their appearance.

From the brain of the reptiles two types of brain are evolved. One, the type found in the lower mammals, develops through an increase in the size of the cortex; the other type, found in birds, is characterized by a marked increase in the size of the palæencephalon. Because of this marked increase in the size of the palæencephalon we find that the instinctive activities of birds are much more varied and complex than those of amphibians and reptiles. In fact, in birds the instincts are so complex that it is difficult to tell which activities are dependent upon the palæencephalon, and which upon the neencephalon. It suggests the possibility of there being neencephalic instincts. The fact that birds make more use of sight than reptiles is easily accounted for, as birds are the first to possess an optic tract leading from the palæencephalon to the cortex. This means that through association these optic impressions are capable of being utilized later, which is not possible in the case of reptiles.

In the mammals we find a brain which has so large a neencephalon that we may expect a subordination of the reflexes and instincts to associative and intelligent action. And this seems to be the case with those mammals in which the neencephalon includes more than half the bulk of the entire brain.

Although our knowledge of the mammalian brain is by no means complete yet it is sufficient to establish the point that man does not possess the greatest associative power in all fields, for the "degree of development of certain parts of the cortex makes it appear highly probable that many mammals far excel man in their capacity for observation and association in certain fields."

This article contains valuable suggestions for the comparative psychologist. In the first place, it shows that much useless work has been done because of the psychologist's ignorance of brain anatomy. For example, what folly to spend time in devising experiments to test association in animals which do not possess the associative structure!

In the second place, the article suggests the importance of choosing certain animals for experimentation, not simply because they are easy to study, but because they represent important stages in evolution. It is evident that a careful study of the bony fishes which possess the palæencephalon alone, and the reptiles which possess a very simple neencephalon will be of marked value when it comes to analyzing the activities of the higher mammals.

But in order for the comparative psychologist to profit by these suggestions it is necessary for him to have a thorough knowledge of brain anatomy. This means that our students of comparative psychology can advantageously spend more time in the study of biology and anatomy than they have been doing.

In a field as new and as broad as that of comparative psychology it is highly essential that the work should be done on those animals where it will count for the most as a basis for subsequent investigations.

CHARLES SCOTT BERRY.

UNIVERSITY OF MICHIGAN.

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